I. C. 6692

March, 1933

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MINING, TREATMENT METHODS, AND COSTS AT THE WESTERN INDIANA GRAVEL CO.'S PLANT NO. 1, LAFAYETTE, IND.

BY

DENIS DWYER

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MINING, TREATMENT METHODS, AND COSTS AT THE WESTERN INDIANA GRAVEL CO.'S PLANT NO. 1, LAFAYETTE, IND.[1]

By Denis Dwyer[2]

This paper describing mining, treatment methods, and costs at Plant No. 1 of the Western Indiana Gravel Co. at Lafayette, Ind., is one of a series on gravel and sand mining being prepared for and published by the U. S. Bureau of Mines.

These papers are designed to disseminate technical information regarding the methods used. The cost tabulations represent operating expenditures only and not total costs. It is recognized that publication of total costs might in many instances cause embarrassment to individual producers, as well as to the industry as a whole. On the other hand, operating costs are essential to the technical discussion and study of the methods employed. The attention of the reader is specifically called to this differentiation in order that no misunderstanding of the scope of the cost tabulations shall ensue.

ACKNOWLEDGMENTS

The author wishes to acknowledge the assistance of J. R. Thoenen, mining engineer of the Bureau of Mines, in the preparation of this paper.

HISTORY

In the early days, or, more specifically, some 20 years ago, the C.C.C. & St.L. Railway Co. acquired as a source of gravel ballast a strip of land adjoining its right of way about 1½ miles northwest of Lafayette and about ½ mile north of the Wabash River. It operated this pit for a number of years for the sole purpose of furnishing its own ballast.

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[1] - The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6692."

[2] - One of the consulting engineers, U. S. Bureau of Mines, and chief engineer of the Western Indiana Gravel Co.

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In 1916 the Western Indiana Gravel Co. was organized and obtained a lease from the railroad company on the land. It immediately started the erection of a completely modern plant which at that time was one of the largest in the industry, having a capacity of 2,000 cubic yards per 10-hour shift with only enough bin storage to allow for loading cars as spotted.

From year to year the plant operated with only a few minor changes. In 1920 a reorganization was effected, the new company acquiring all the holdings of the old company.

Upon the depletion of the railroad deposit, more ground was acquired, and at present the company controls approximately 200 acres.

GEOLOGY

The greater part of Indiana is in the glacial plains region of the upper Mississippi Basin, and surface forms are those produced by the constructional phases of glaciation. Approximately 30,100 square miles of the State have been subjected to glaciation, while only about 6,250 square miles have been untouched by glacial ice. The area north of the Wabash River still largely retains the original forms following glaciation but little modified by stream erosion.

The middle portion of the State is largely a great till plain, which has been modified to only a slight degree by stream action. No lakes exist, though marshes and swamps were formerly common throughout most of the territory and have since been artificially drained. Farther south the glacial plain is older and the streams larger. Considerable dissection of the glacial plain has taken place along the Wabash River in the area between Lafayette and Terre Haute. This plain must have been a large trunk stream before its partial destruction by the several glacial invasions from the north.

The Wabash Valley as developed by the waters from glacial Lake Maumee and other ice-discharged waters which came into it, extending from Fort Wayne west and southwest to near Delphi, is cut from 50 to 125 feet below the bordering plain and is ¼ to 1 mile wide. Much of this course is cut through glacial drift, and occasional bedrock bluffs rise sharply from the valley floor. From the vicinity of Delphi the Wabash Valley follows a broad preglacial valley from which the glacial material has been partly removed. It is apparent that glaciation filled this preglacial valley, and through Tippecanoe, Warren, Fountain, Vermilion, and Parke Counties to the Shelbyville moraine, the glacial material has been re-excavated to a depth of approximately 200 feet below the plain. This valley is much wider here than in the portion above Delphi and is flanked by two sets of terraces, the higher one approximately 150 feet above the river. Prominent remnants of this older glacial valley floor occur as broad, level gravel plains, such as those on which Purdue University and the property of this company are located.

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The glacial drift in most of northern Indiana covers the bedrock to such a depth that it is not exposed even by the larger streams. In this region the only road material available consists of bowlders, sands, and gravels from the glacial drift. The coarser materials of the drift are concentrated in moraines, drumlins and eskers. Good examples of drumlins are found in the vicinity of Valparaiso, South Bend, Bristol, Otterbein, Fowler, and Lafayette. During glaciation large quantities of sand and gravel were carried from the glaciated region by the waters of the melting ice and concentrated in stream valleys, many of which were almost completely filled.

The deposit contains about 60 per cent sand and 40 per cent gravel, with about 20 per cent oversize between 3 and 12 inches in diameter which requires crushing.

METHOD OF PROSPECTING

The first exploration of the property was by open pits dug by hand. This method proved unsatisfactory on account of the cost and the limited depth attained. At present, prospect holes are dug on contract at $1.50 per foot. The equipment used consists of a number of telescoping tubes approximately 3 feet in diameter and 4 feet long made of 12-gage steel. These tubes are put in place by the use of a steel tripod set directly above the hole and carrying a 1-inch manila rope run to a hand winch. One man works in the hole and one man on the surface. The material is loaded out and piled to one side on top. A depth of 50 feet can be attained by this method. The prospect holes are placed in checkerboard fashion at 100-foot intervals. An accurate log is recorded for each 2 feet in depth and a screen analysis is made of the material from each hole after the hole is completed.

CHOICE OF METHODS

As the product originally desired was principally ballast, the plant was designed to take care of peak ballast loading. A small local market for concrete gravel existed at that time but it later increased notably with the building of state highways and local city streets. A general layout of the plant is shown in Figure 1.

STRIPPING

The overburden varies from 2 to 4 feet in depth and consists of a heavy black soil. The underlying gravel deposit ranges from 15 to 30 feet in thickness. The overburden is stripped by the use of a full-revolving electric drag line mounted on railroad-type trucks and equipped with a 100-foot structural-steel latticed boom. The power necessary to operate this machine is furnished by the Northern Indiana Light & Power Co. via a 2,200-volt alternating-current line run through the substation at the plant and carried on a pole line. Cutouts are placed every 500 feet on the pole line to provide connections for a 500-foot ground cable leading to the drag line. The current is reduced at the machine to 440 volts. The electric motors on the drag line are one 200-hp., variable-speed, intermittent-duty, 600-r.p.m. motor which operates the hoist and drag drums; and one 75-hp., variable-speed, intermittent-duty, 700-r.p.m. motor which operates the swinging mechanism.

A 4-cubic yard bucket is used. The drag line is set on top of the bank and casts the overburden into the worked-out area of the pit, which eliminates any possible necessity of rehandling it in the future. This stripping is usually done in the early spring or late fall. Two men are engaged in this work, one drag-line operator and one ground man. Approximately 47,900 tons of overburden were moved in the spring of 1929, and the balance, or 33,000 tons, was removed intermittently as necessary during the year. All the wire rope used on the drag line is patent flattened strand. The drag cable is a 1-3/8-inch diameter, 6-strand, 19-wire rope 150 feet long, and lasts about nine months. The hoist cable is a 7/8-inch diameter, 6-strand, 19-wire rope 450 feet long, and lasts a year. The boom cable is a $\frac{3}{4}$-inch diameter, 6-strand, 19-wire, 150-foot rope which will give many years service. The use of the drag line eliminates loading and transporting the overburden in cars and completes the stripping in one operation.

EXCAVATION

In opening the gravel bed the drag line was set up on the surface to remove the overburden in an easterly direction for a distance of 800 feet and a width of 120 feet. The overburden was cast to the excavated pit. The machine was then returned to the starting point to strip a similar area at right angles, proceeding south for a distance of 1,500 feet. While stripping this second area a No. 51 railroad-type steam shovel was moved into the area stripped first to dig a cut from the bank, proceeding east. This operation left an open cut between the gravel bank and the pile of overburden discarded by the drag line. Tracks were laid in this cut to follow the shovel and supply it with cars.

When the drag line had completed the stripping to the south it was returned to the east cut, as shown in Figure 1, and the shovel was moved to the south cut to open it up.

The portable hopper was then brought in on the east cut, and the drag line proceeded to load gravel from the bank left by the shovel. In this way gravel is loaded by both the drag line and shovel from the east and south cuts simultaneously. The shovel has a 2-yard dipper and loads directly into cars on the pit track which parallels the shovel track. Five men are required to operate the shovel. The electric drag line is more economical than the shovel for loading, as its operation does not require a water supply line or transportation of coal. The shovel, therefore, is operated only as an auxiliary.

The portable hopper is structural steel throughout and has a capacity of 31 cubic yards. This hopper is on the pit floor directly over the pit track and is so constructed as to allow clearance for the dinkey engine and the loading of standard railroad equipment. It has an especially wide tread, is mounted on four sets of trucks with double flanged wheels, and is moved

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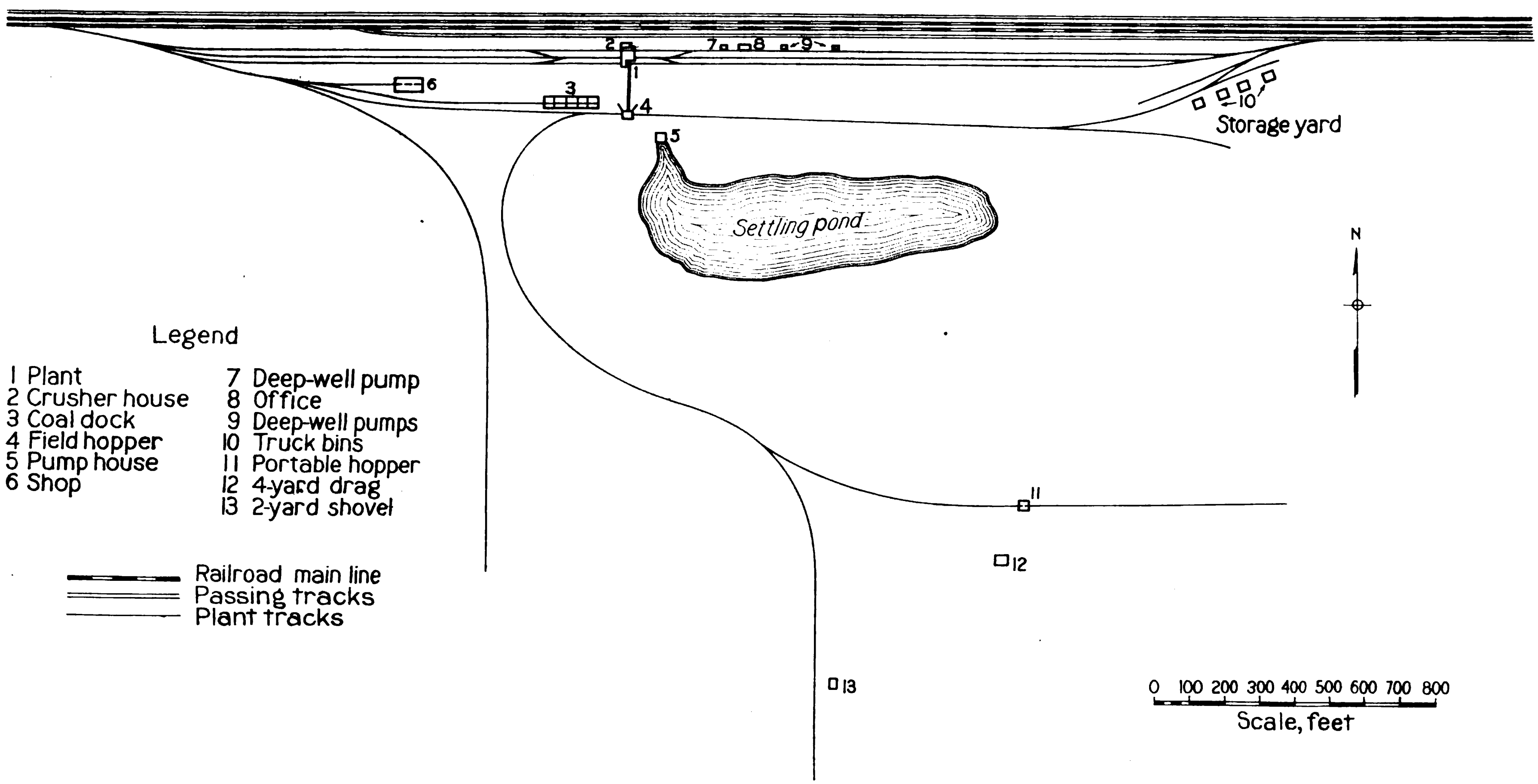

Figure 1.— General layout of plant

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on 100-pound rail. The hopper is easily moved by the dinkey. An inverted-rail grizzly with 9-inch spacing is mounted on top of this hopper. The large bowlders that are retained on the grizzly are pulled off on the side near the drag line. The hopper has twin roller discharge gates to speed up loading of the cars and to eliminate the possibility of clogging with flat rocks that pass through the grizzly. A train can be loaded with this hopper in two minutes. One man attends to loading at the hopper.

TRANSPORTATION

Trains of six 8-cubic yard, side-dump cars are used to transport pit gravel to the field hopper (fig. 3). The trains are hauled by 21-ton, saddle-tank, steam locomotives.

One man is needed on each train as locomotive engineer, one ground man at the switch, and one man at the field hopper to dump the cars.

SCREENING AND CRUSHING PLANT

Figure 1 shows the general plant layout. Figure 2 is a plan and Figure 3 an elevation of the screening and crushing plant.

The pit gravel is transported by train to a concrete field hopper which has a capacity of 30 cubic yards. An inverted rail grizzly on top of this hopper has a 9-inch spacing. A 24 by 30 inch reciprocating feeder is placed at the discharge of the hopper to provide a uniform feed to a conveyor belt. This feeder is driven at 18 r.p.m. by chain and sprockets from the conveyor tail shaft and is equipped with a manganese-steel wearing plate. One man is employed on top of the hopper to dump the cars and also to watch and operate the feed to the conveyor belt. This 30-inch, rubber-covered conveyor runs on an incline of 22°, is 205 feet between centers, and travels 300 feet per minute. An automatic vertical take-up is used. There is a gear reduction drive at the top of the plant and the conveyor is powered by a 60-hp. motor making 700 r.p.m. and driving through a 12-inch, 8-ply belt.

SCREENING

The conveyor discharges into a 60-inch diameter, trunnion-type, double-jacketed rotary screen 22 feet long. The inner screen for 12 feet 9 inches of its length is perforated with $1\frac{3}{4}$-inch round holes, then for 2 feet $10\frac{1}{2}$ inches with $2\frac{1}{2}$-inch round holes, and for 3 feet with 3-inch round holes. The middle jacket is $74\frac{1}{4}$ inches in diameter by 11 feet long and has 5/8-inch round perforations. The outer jacket is 87 inches in diameter by 10 feet long and has 5/16-inch round holes.

This screen has a slope of 6° and makes 12 r.p.m. It is operated through a gear-reduction belt drive by a 20-hp., 1,200-r.p.m., 440-volt motor. About 1,200 gallons of water per minute is supplied to this screen by a 6-inch line inside the screen, the pipe being perforated with $\frac{1}{4}$-inch holes. Approximately 200 tons of gravel per hour pass through this screen.

The approximate tonnages handled by the screen are:

Size	Tons per hour
Plus 3 inch	20
Minus 3 inch plus 2½ inch	10
Minus 2½ inch plus 1¾ inch	12
Minus 1¾ inch plus 5/8 inch	16
Minus 5/8 inch plus 5/16 inch	22
Minus 5/16 inch	120

The life of the main screen--specifically, the receiving end and discharge end, trunnion rings, and annular spur gear--is approximately three years; the wearing plates in the receiving and discharge ends are replaced once a year. The life of the jackets is one-third of a year. The length of the operating season is 10 months.

The graded material from 2½-inch down to 5/16-inch size is fed onto a 3 by 8 foot triple-deck vibrating screen placed directly under the hopper of the gravel screen and set at an angle of 25°. The top deck on the vibrator is equipped with woven wire having 1-inch openings, the middle deck with woven wire having ½-inch openings, and the bottom deck with woven wire having ¼-inch openings. The wire cloth is mounted on angle frames, and each deck is in two sections, making it easy to replace the screens. The vibrator is driven by a 3-hp., 1,200-r.p.m. motor and operates at 1,250 r.p.m., handling about 80 tons of gravel per hour. Approximately 600 gallons of water per minute is supplied to this screen by a 2-inch pipe line discharging through T-shaped sprays spaced about 1 foot apart. The screen cloths last approximately a month.

The vibrator is used as a rewash and grading screen. The three sizes of gravel from minus 2½-inch to plus 5/16-inch are recombined and sent to the vibrator screen for final sizing and a second washing. Spouts from it are so arranged as to grade the material to the requirements of the general market, to by-pass it to the waste bin, or for direct loading as ballast.

The material graded for the market by the vibrator screen goes to the centering hopper, which feeds the elevator to the scrubber screen. Other grades are taken directly from the gravel screen.

The total material sent to the vibrator screen amounts to approximately 80 tons per hour. Roughly 28 tons per hour are retained on the top deck, 20 tons per hour on the middle deck, and 22 tons per hour on the bottom deck, with only the rewash water and the fines (10 tons) not removed on the gravel screen passing the bottom deck but flumed directly to the sand box.

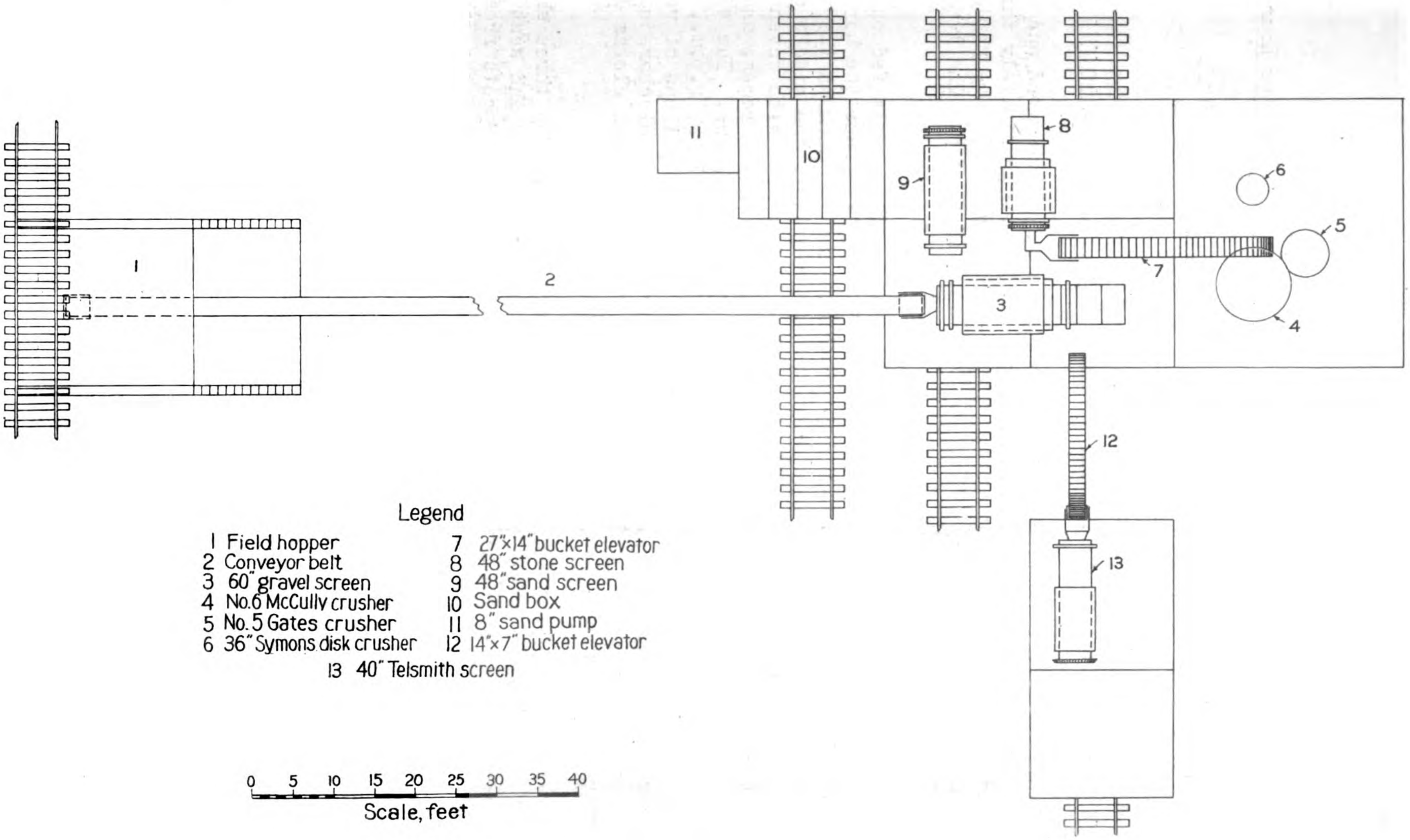

Figure 2.-Plan of screening and crushing plant

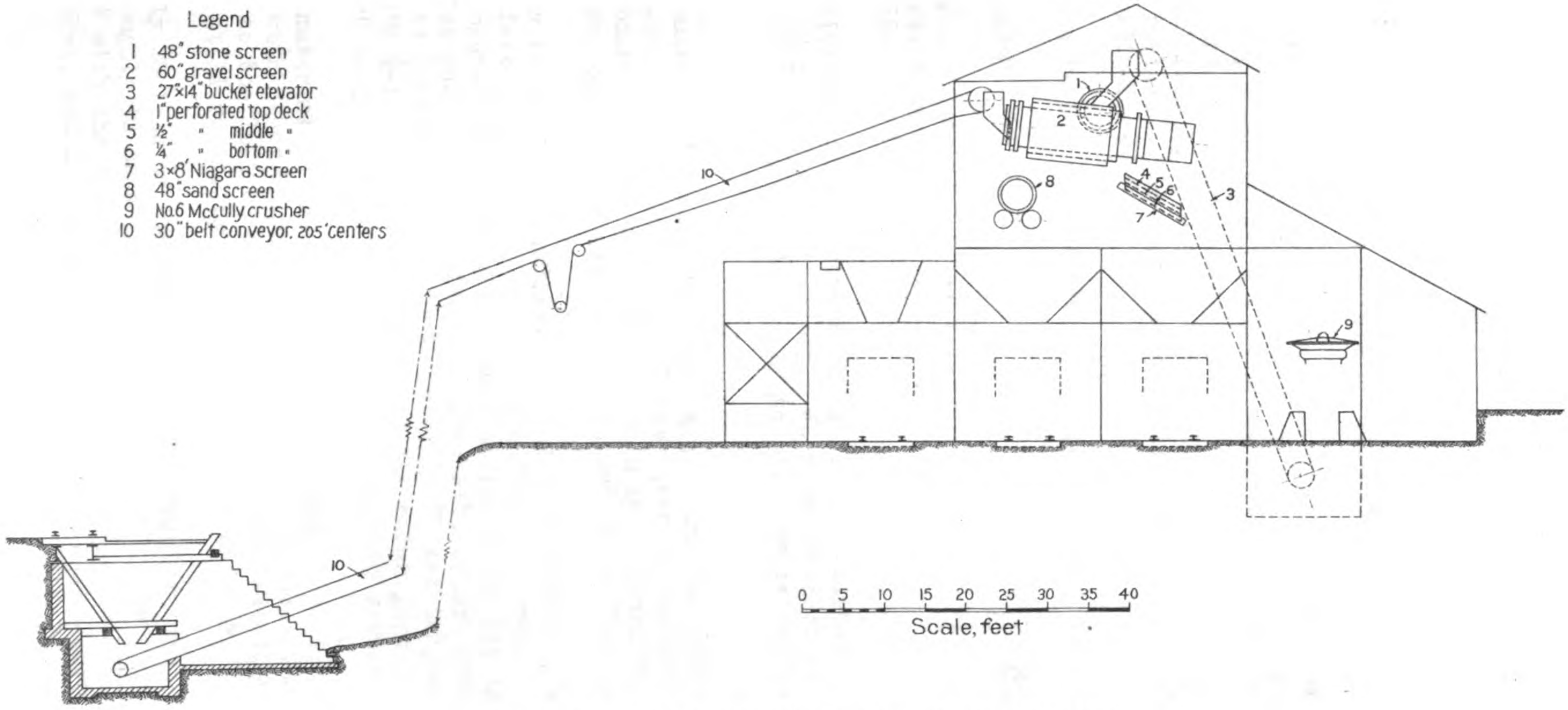

Figure 3.–East elevation of screening and crushing plant

CRUSHING

Three crushers are used in the crushing plant, which is located north of the loading tracks. The crushers are mounted on reinforced-concrete foundations, the tops of which are approximately 8 feet above track grade.

The primary crushing of the plus 3-inch material from the gravel screen is done with a No. 6 gyratory crusher set at 3 inches. The secondary crushing is done by a No. 5 gyratory and a 36-inch disk crusher, the discharge openings of which vary with the product desired but are normally set at 1 or 1½ inches. Material from 1¾ to 3 inch size is fed to these two crushers in making pebbles or ballast. The crushers are belt driven from a line shaft run by a 100-hp., slip-ring motor.

The normal feed to the crushers is as follows:

Crusher	Tons per hour
To the No. 6 gyratory	20
To the No. 5 gyratory	15
To the 36-inch disk	25

The feed is divided equally between the secondary crushers except for the circulating load from the stone screen. When material of 1-inch size and finer is required, all material from 2½ to 5/8 inch is fed to the disk crusher.

The crushed material is fed through a common spout to a 27 by 14 inch, steel-link chain elevator, approximately 82 feet between centers and sloping at 76°. A gear-reduction drive with silent chain is operated by a 20-hp., 700-r.p.m. motor and drives the elevator at a speed of 90 feet per minute.

The discharge is into a 48-inch diameter, double-jacketed, trunnion-type rotary screen 14 feet long, termed localled the "stone" screen. The inner screen of ½-inch plates is pierced for 8 feet 6½ inches of its length with 1¼-inch round holes and then for 3 feet 3 inches with 2-inch round holes. The inner jacket is 5 feet 6 inches in diameter by 7 feet long and is made of 3/8-inch plate with ¾-inch round perforations; the outer jacket is 6 feet in diameter by 6 feet long and is made of ¼-inch plate with ¼-inch round holes.

The crushed material is graded and washed by the stone screen and is mixed by gravity with other material in steel-lined chutes. The plus 2-inch material returns to the 36-inch disk crusher for final reduction. This screen is driven at 11 r.p.m. by gear reduction from a 15-hp. motor.

Approximately 30 tons of crushed material is handled per hour by the stone screen. Roughly 10 tons per hour are retained on the 2-inch jacket in closed circuit with the disk crusher, 10 tons on the 1¼-inch jacket, 8 tons on the ¾-inch jacket, and 2 tons on the ¼-inch jacket, and 10 tons pass the ¼-inch screen.

The life of the main screen--specifically, the receiving end, discharge end, trunnion rings, and annular spur gear--is approximately three years; the wearing plates in the head and foot end are replaced once a year. The jackets are replaced every three months.

The sand or minus 5/16-inch material passing the gravel screen is fed to a 48-inch diameter, trunnion-type rotary screen set at right angles to the gravel screen. This sand screen is 16 feet long and slopes at 6°. It has a 15-foot supporting barrel 5 feet 3 inches in diameter made of 3/8-inch plate with 2-inch round perforations, with an inner jacket of woven wire in 3-foot panels having 1/8 by 5/8 inch slotted openings. This screen is equipped with gear-reduction drive belted to a 15-hp. motor and revolves at 9 r.p.m. The plus 1/8 to 5/16 inch material retained on the jacket is regulated by butterfly gates so as to feed in allowable amount to the concrete-sand or the waste bin.

The undersize is flumed to a wood settling box which is directly over the No. 3 loading track. The settling box is 10 feet wide by 16 feet long by 9 feet deep. The overflow from this box goes either to the settling pond or directly to an 8-inch sand pump which transfers it to the worked-out area of the pit. The sand settled out in the box is removed and sold as mason's sand.

The material passing the 5/16-inch outer jacket on the gravel screen forms the feed to the sand screen. This varies from day to day but will approximate 120 tons per hour. Of this about 48 tons is rejected and is flumed to the concrete-sand bin or to waste.

The material passing the sand screen, augmented by the fines from the stone screen and the vibrator screen, goes to the sand box at the rate of about 100 tons per hour; of this amount 75 tons are settled out as mason's sand and 25 tons are sent to waste.

The jackets in the sand screen are replaced monthly. Bamboo brushes are mounted on top of the screen to prevent blinding.

The discharge line from the waste-sand pump is of 8-inch pipe and is approximately 900 feet long. The pump is fitted with manganese steel throughout and is directly connected to a 100-hp., 900 r.p.m., slip-ring motor. On an estimated pumpage in 1928 of 86,733 cubic yards, the cost was $0.036 per cubic yard.

Early in 1929 it was found necessary to install a rewash screen in order to meet State specifications for pebbles. Consequently two new 60-yard capacity bins were built adjoining the main plant. The bins were of steel construction with wood floors and side walls, and were provided with bottom gates for car loading and side gates for truck loading. On the top of the bins a 40-inch diameter by 16½-foot special scrubber screen was placed. This screen has an angle-type, bevel-gear drive with a 6-foot scrubber section equipped with dams and lift angles. The rest of the screen is of perforated plate with 3/8-inch round holes and is jacketed by a screen with ¼-inch round holes. The

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screen has a slope of about 6°, uses 400 gallons of water per minute, and has a capacity of 75 tons per hour. It is driven at 14 r.p.m. by a 10-hp., 1,200-r.p.m. motor. The scrubber section lasts about a year and the outer screen about 10 months. The rewashed pebbles from the screen are discharged into the bins underneath for loading.

The scrubber screen is fed by a continuous bucket elevator, with 14 by 8 inch buckets mounted on an 8-ply, rubber-covered elevator belt, running at a speed of 90 feet per minute. The function of the rewash screen is to rinse the material to remove any sand, but primarily to remove the yellow cast caused by the tumbling action of the gravel in its travel against the soft impurities. Pebbles from $\frac{1}{4}$ to $2\frac{1}{2}$ inches in diameter are fed from a centering hopper, directly underneath the vibrator screen, onto a short 20-inch conveyor belt operating at 250 feet per minute, which in turn feeds the bucket elevator. This elevator is driven by a 10-hp., 1,200-r.p.m. motor through a gear-reduction drive, and its feed conveyor is driven by chain and sprockets from its foot shaft.

Water is supplied to the plant by centrifugal pumps at the settling pond, which is fed by natural drainage and by three 8-inch, double-action, 375 gallons per minute deep-well pumps having a lift of about 72 feet. The three pumps are separately driven by 15-hp. motors. The total supply of fresh water to the main plant is 3,375 gallons per minute. Three centrifugal pumps are used to supply the plant; one 10-inch, single-stage pump with a capacity of 2,400 gallons per minute at 1,750 r.p.m., direct-connected to a 100-hp., slip-ring motor; one 5-inch pump with a capacity of 600 gallons per minute at 1,750 r.p.m., direct-connected to a 20-hp., slip-ring motor; and one 3-inch pump having a capacity of 375 gallons per minute at 1,750 r.p.m., belt driven by a 5-hp. motor. All three work against a total friction and static head of 90 feet. The pressure at the pumps is 30 pounds.

The electric power for the plant is furnished by the Northern Indiana Light & Power Co., which brings power at 11,000 volts to a substation adjoining the main plant, where it is transformed to a 440-volt current for operating the plant. The average cost of electric power is $0.04 per kilowatt-hour.

The plant capacity is 3,000 tons per 10-hour shift. A night shift is used when business warrants.

The C.C.C. & St.L. Railway and the Nickle Plate Railroad serve the plant. Ample storage is provided for both empty and loaded cars. The storage for empties above the plant has a capacity of 70 cars and the storage for loaded cars below the plant has a capacity of 90 cars.

STORAGE YARD

The yard for storing material for winter supply is approximately 1,500 feet east of the main plant and is served by two tracks leading off of the Nickle Plate sidetrack. These storage tracks are approximately 800 feet long.

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Material is loaded at the plant either into low-sided gondolas or into hopper cars. The gondolas are unloaded into storage by gasoline locomotive crane equipped with a 1¼-yard clamshell bucket. The hopper cars are dumped into a track hopper and their contents are either put into storage or into the truck bins with the crane.

Three sets of truck bins are used for various grades of materials. Each is a double-compartment bin equipped with batch boxes for both pebbles and sand, and each has ample clearance for driving a truck underneath. Three men are employed in the storage yard--one crane operator and two men for ground and truck loading.

The annual truck loading at the yard averages about 53,750 cubic yards. This material is used in Lafayette in the construction of buildings, streets, and sidewalks.

Two men handle all office work at this plant.

Normally the working day is 10 hours, and the plant operates 6 days per week continuously throughout the working season of 10 months.

SAFETY ORGANIZATION

The plant manager appoints two men from his organization to act with him for 30 days as a safety-first committee, of which he is chairman. This committee holds regular weekly meetings to act on safety suggestions and makes a weekly statement to the general executive committee. The general manager and two other officials of the company compose the general executive committee, which holds monthly meetings and act on the reports and recommendations of the plant committee. An annual prize is offered to the employee who submits the best safety recommendation, and placards and safety-first posters are placed conspicuously about the plant to remind employees constantly of dangers. First-aid kits are placed conveniently in the plant and office to be readily available in case of accidents. This safety organization has proved successful. No serious injuries or lost-time accidents occurred in 1930. Figure 4 shows the plan of administrative organization.

WAGE SCALE 1/

	Per month
Plant manager	$250.00
Office manager	150.00
Office assistant	125.00
Night watchman	90.00

	Per hour
1 foreman	0.75
2 loaders	.50
1 main-plant man	.60
2 car patchers	.40
2 car riders	.40
1 crusher-house man	.45
1 field-hopper man	.40
3 locomotive engineers	.45
1 drag-line operator	.65
1 craneman	.60
5 to 10 laborers	.35

1/ The number of men indicated are employed for one shift.

Table 1. – Summary of costs

Period covered: 1929
Sand and gravel produced, tons: 638,876

Operating cost per dry ton of sand and gravel

Item	Labor	Power	Fuel	Supplies	Total
Stripping	$0.0014	$0.0096	–	$0.0004	$0.0114
Digging	.0075	.0181	–	.0004	.0260
Hauling	.0445	–	$0.0010	.0106	.0561
Screening and crushing	.0480	.0327	–	.0096	.0903
Repairs and maintenance	.0250	–	–	.0048	.0298
Miscellaneous expense	.0056	–	–	.0046	.0102
Total direct cost	0.1320	0.0604	0.0010	0.0304	0.2238
Depreciation	–	–	–	–	.0397
Depletion	–	–	–	–	.0034
Total operating cost	–	–	–	–	0.2669

Table 2. - Summary of costs in units of labor and power

Lafayette Pit No. 1 Period covered, 1929

Tons material loaded during period: Overburden, 30,920
Sand and gravel, 638,876

	Stripping	Mining	Plant	Other	Total
Labor (man-hours per ton of sand and gravel):					
Loading	0.0285	0.1469	0.0098	-	0.1852
Hauling	-	.0049	.0147	-	.0196
Miscellaneous	-	.0049	.0196	0.0147	.0392
Supervision	.0003	.0011	.0011	-	.0025
					0.2465
Average tons per man-shift					40.0
Labor cost, per cent of total					50.0
Power (kw.h. per ton of sand and gravel):					
Drag line	0.2413	0.4515	-	-	-
Crushing	-	-	0.162	-	-
Screening	-	-	.105	-	-
Elevating	-	-	.032	-	-
Conveying	-	-	.284	-	-
Washing	-	-	.235	-	-
Lighting	-	-	.0005	-	-
Tons of coal per ton sand and gravel					0.004
Supplies and power, per cent of total					34.4

Table 3. - Detailed average drag-line costs per ton, direct operation

Lafayette Pit No. 1 Period covered, 1929

Electric drag line, 4-cubic yard scraper

Tons material handled during period: Overburden, 80,920
Sand and gravel, 638,876

	Sand and gravel	Over-burden	Total material	Total cost, sand and gravel
Labor:				
Engineers	$0.0045	$0.0066	$0.0048	$0.0053
Pitmen	.0025	.0038	.0027	.0030
Total operating labor	0.0070	0.0106	0.0075	0.0083
Power	.0180	.0761	.0245	.0277
Grease and lubricants	.0001	.0005	.0002	.0002
Repair labor	.0005	.0018	.0006	.0007
Repair supplies	.0003	.0011	.0004	.0005
Total operating cost	0.0259	0.0901	0.0332	0.0374

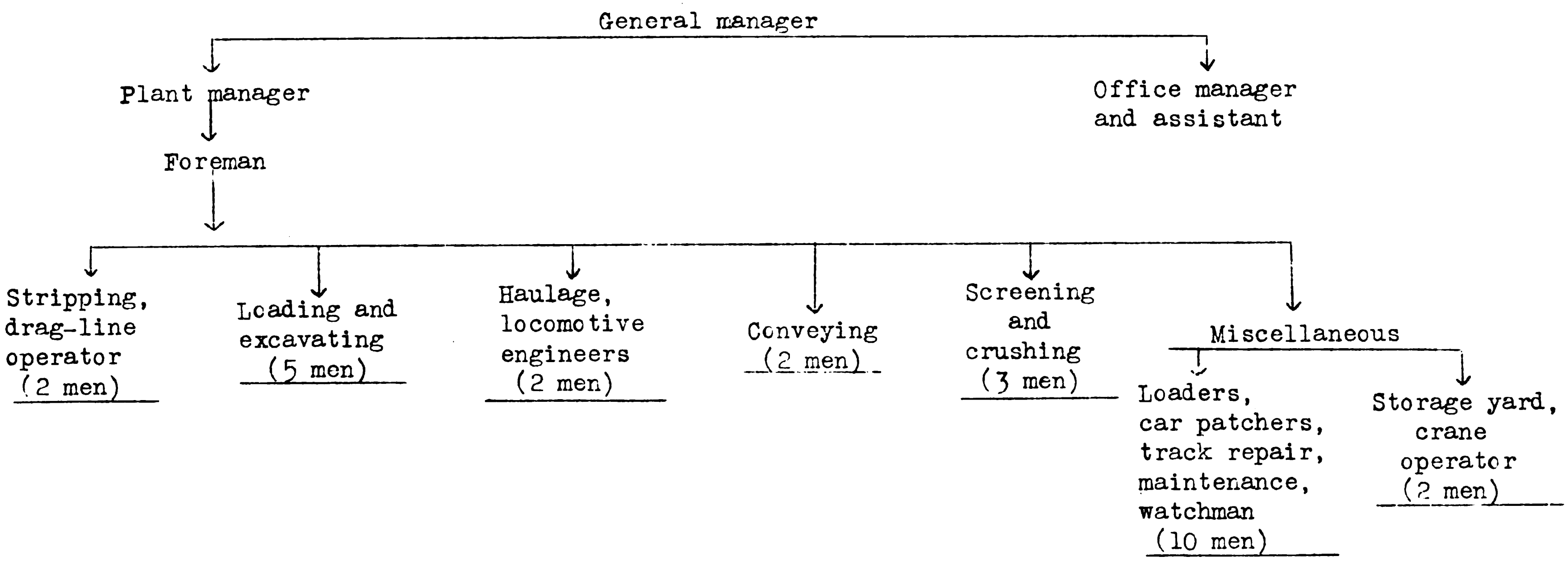
General manager
Plant manager
Office manager and assistant
Foreman
Stripping, drag-line operator (2 men)
Loading and excavating (5 men)
Haulage, locomotive engineers (2 men)
Conveying (2 men)
Screening and crushing (3 men)
Miscellaneous
Loaders, car patchers, track repair, maintenance, watchman (10 men)
Storage yard, crane operator (2 men)

Figure 4.- Administrative organization chart

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